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Abstract

This repcrt presents a descriptlcn of the Structure-Process approach to ccgnitlcn and literacy, suggests techniques fcr implementation of the mcdel, and assesses the effects of the model on a specific populatlcn. The Structure-Process apprcach assumes that intelligence develcps cumulatively. The model was used for curriculum development in fcur rural and urban early childhccd centers enrolling 290 3- to 7-year-old disadvantaged Negro children. A checklist was filled cut by the teacher three times during the year to assess each child's prcgress in communicatlcn, fine arts, and physical activities. Analysis of variance results shcwed significantly higher gains fcr girls ccmpared to bcys, perhaps reflecting maturational superiority and/or teacher favoritism. Pre- and postadministration cf the Preschool Attainment Record produced significant gains on measures of creativity, and physical, social, and intellectual development. According tc pre- and posttest scores on the Slcsson Intelligence Test, the program had maximum effect cn ycunger children. Crcss-test ccmparisons using the Wechsler Preschool and Primary Scale of Intelligence and variations in

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A STRUCTURE-PROCESS APPROACH TO COGNITIVE DEVELOPMENT OF PRESCHOOL NEGRO CHILDREN: RATIONALE AND EFFECTS*

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The major purposes of this report are: (1) to present a rationale and description of the Structure-Process approach to cognition and literacy; (2) to describe techniques for implementation of the Structure-Process model; and (3) to assess the effects of the Structure-Process approach on the cognitive development of 290 three-to seven-year-old Negro children enrolled in four early childhood centers located in economically depressed areas of Texas and Louisiana during the 1967-1968 school year.

The evidence supporting compensatory programming for young children is universal knowledge amoung educators, and this report is lengthy. Consequently, the traditional statement of need has been deleted.

A Structure-Process Approach to Cognition and Literacy: Rationale and Description

The Structure-Process approach to the development of cognition and literacy in young children is an emerging effort to form a working relationship between two complimentary but oft-divorced behavioral sciences - psychology and education. Whenever the researcher attempts to generalize from principles tested through basic research, i.e., research in learning, to classroom application he must initially accept a great deal on faith. This is characteristic of theory building, where initial concepts are established, subjected to experimentation, and eventually evaluated and revised until the theoretical system is sufficiently substantial to merit general acceptance and application.

> In the structure-process approach, cognition is defined as the exercise of the higher mental processes, totally dependent upon but essentially different from the organism's learning processes. Intelligence, which embraces both learning and cognition, is defined as the organism's ability to adapt to increasing complex and sohpisticated internal and external environmental situations and stimuli. In this conceptualization, learning and cognition are seen as separate but correlated and interdependent factors of intelligence, with integral relationships to the neuro-physiology of the brain (Frost and Rowland, 1968, p. 385).

The structure-process model evolved from a synthesis of theoretical and research reports in the area of cognition (Rowland 1967; and Frost and Rowland 1968,1969)

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A concept having communality among the written works of eminent psychologists, though labeled differently, is accepted as having validity for the construction of models for the instruction of children. The approach emerging from the present review and syntehsis appears to have wide applicability to the design of programs for the development of cognition and literacy; and any content field can be accommodated within the framework of the structure-process model.

Psychological Evidence for a Cognitive Hierarchy of types of learning and described cotnition in terms of "abilities". In a related approach, he defines "productive learning" as a change in human behavior permitting successful performance on classes of specific tasks. When performance is thus changed, the acquisition of a capability is assumed. The two major variables in productive learning are knowledge (that which the learner brings to the task) and instructions. In structuring or defining knowledge, Gagne constructs an ordered hierarchy of subordinate knowledges (capabilities) called learning sets. Productive learning, then, is the transfer of training from component (subordinate) learning sets to a new activity which incorporates these previously acquired capabilities. Gagne identifies "individual differences" as the major methodological consideration emerging from his studies, suggesting that current measures of proficiency are undependable and fail to determine the capabilities already established in the child's cognitive structure.

Although we are yet to present the related conclusions of other psychologists, the two major components of the approach herein described--structure and process--have gained a distinct place from the work of Gagne alone. Structure, referring to the presumed hierarchical, cumulatively accumulating nature of knowledge, and process, referring to instructional acts which relate distinctively to the accurate assessment of accumulated cognitive structure and establish techniques, procedures, and materials to build sequentially upon these structures. In other words, process is the introduction of controlled discontinuity on a base of continuity.

Gagne (in 1968) carries his thinking further to contrast his model for learning with two other well-known models. The growth-readiness model, which is associated with the names of G. Stanley Hall and Arnold Gesell, states briefly that "certain organized patterns of growth must occur before learning can effectively contribute to development", meaning that training for a desired performance might as well, and probably should, wait until the child is maturationally "ready". The second well-known model is the cognitive adaptation theory of Jean Piaget. Piaget recognizes that development is enhanced by the interaction of the child with his environment. As new experiences are assimilated into existing cognitive structures, newly acquired structures make it possible for the organism to accommodate to the demands of the environment. Whereas, the recognition of hierarchical structure acquisition is common to both Piaget and Gagne, the relative contributions of maturation and learning represent a point of departure between the two theorists. Piaget believes that development influences learning more than learning influences development and views learning as merely a factor involved in adaptation. Gagne, on the other hand, emphasizes learning as a major causal factor in development. The entities that are learned build upon each other in a cumulative fashion--and learning transfer occurs among them, leading to ever increasing complexity of interaction between capability structures and the generation of ever increasing intellectual competence.

Piaget (1947) views intelligence as the grouping of operations according to certain definite structures. The constant building of experiences results in increasingly complex structures or schemas. Experience, however, operates with three other factors--maturation, social transmission, and equilibration--in influencing intellectual growth. The development of intelligent behavior proceeds through four major stages--sensorimotor, preconceptual, concrete and formal. The sequence of movement through these stages is invariant except in cases of severe deprivation such as is sometimes found in orphanages, but the rate and timing of development is highly variant, different for every human organism. Time, per se, has no legitimate function in the sequence, serving only as a backdrop against which developmental events transpire. The attainment of particular intellectual tasks characteristic of any developmental stage is dependent upon successful attainment of lower order or subordinate tasks. For example, the child must grasp the principles of conservation of quantity before he can develop the concept of number (Piaget, 1965). Gagne (1968) explained that children who cannot match liquid volumes (conservation of liquid) do not simply lack such logical processes as "conservation", "reversibility", or "seriation", but such information as concrete knowledge of containers, volumes, areas, lengths, widths, heights, and liquids. This view is directly related to the practical applications of the structure-process model in the experiment to be described.

G. A. Ferguson (1954, 1956) is the third major figure whose approach to cognition contributed to the development of the structure-process model. His 1954 paper presented the fundamentals of his theory of human abilities and his 1956 contribution clarified and refined the original views. The broad features of Ferguson's theory are: (1) the abilities of man (subsumed under intelligence) are attributes of behavior, relatively stable in adults but less stable in children because of variation in prior acquisition and the emergence of specific abilities; (2) biological factors in the formation of ability fix limiting conditions but within these boundaries environmental determinants in learning have substantial power; (3) cultural factors result in different patterns of ability; (4) abilities emerge through a process of differential transfer; and (5) positive transfer accounts for a general intellective factor, learning itself being viewed as a process whereby the abilities of man become differentiated, and facilitated at any stage by the abilities already possessed by an individual. Ferguson defines ability as: (1) measures of performance in any situation; (2) a factor in the methodology of factor analysis; or (3) some attribute of the state of the organism, presumed to be functionally related to observable performance in particular tasks.

Feguson explains transfer, a crucial concept in his theory, in terms of the mathematical concept of a function, when two variables are so related that the values of one are dependent on the values of the other, concomitant change results, i.e., change in performance on one task will result from practice on another. Ferguson maintains that the abilities of man are among those certain aspects of the state of the organism that attain a crude stability or invariance. Thus behavior becomes organized, or structured, and to some extent predictable. A primary object of psychological and educational endeavor therefore becomes the discovery of these invariants in the behavior of the human organism. In the present context, experimentation with disadvantaged children, it seems advisable to note that Ferguson theorizes: "Everything we know suggests that different environmental demands lead to the development of different ability patterns. The concept of a culture-free test is a misconception because the abilities of man are themselves not culture-free (1956, p. 129). The concept of individual differences, long theoretically accepted but practically denied by schools, arises again. The existence of abilities

is common to man but the nature of abilities among individuals is highly variant.

Bruner and his associates provide a fourth major body of knowledge contributing to the structure-process approach. Bruner (1964) describes three processes by which people come to know: (1) enactive--trhogh habitual actions; (2) iconic--through imagery that is relatively free of action; and (3) symbolic--the translation of action and image into language; as well as Bruner's (1956) ideal strategies. Olson (1966), an associate of Bruner, accepts these processes and presents three strategies emerging from their work: (1) searching (approximately three years), a quasi-systematic search for the stimulus situation; (2) successive pattern matching (five years), a concentration on the pattern and model; and (3) information selection (seven years) where the child tends to eliminate redundancy and is more likely to achieve the solution to a problem with a minimum of information. To deal successfully with the more advanced information selection requires that the child be able to deal with properties of several images simultaneously, as well as the ability to construct a hierarchy of distinctive features. As the child approaches symbolic representation, the strategies that are employed in finding and using information change drastically as the more powerful tools characteristic of this stage or level become available. Conceptualization of the domain of alternatives in information selection is necessarily hierarchical, for information leading to the acceptance or rejection of subsets leads one to the use of a feature to distinguish further among the remaining alternatives.

These distinguished psychological studies appear to support a common element or factor in cognitive development. The list is admittedly incomplete for other prominent psychologists could be added, e.g., Harlow's (1949) learning sets.

Psychologist	Common Elements
Gagne	capabilities
Piaget	principles
Ferguson	abilities
Olson and Bruner	strategies

The psychological bases herein established may be strengthened further by the addition of neuro-physiological evidence.

Neuro-Physiological Evidence for a Cognitive Hierarchy

The classic work of Hebb (1949) gives substantial basis for perfect correlation of behavior and neural function, (viewing correlation as causal rather than related). He argues for predictability in psychology (the author would add education). "One cannot logically be a determinist in physics and chemistry and biology, and a mystic in psychology (p. xiii)". Hebb regards "mind" as the activity of the brain and the problem of understanding behavior

as a problem of understanding the action of the neural system, and vice versa. He rejects the telephone switchboard theory of cortical transmission, emphasizing intervening processes. Stimulation leads to the development of a diffuse structure of "cell-assemblies", capable of acting briefly as a closed system, delivering facilitation to other such systems. Disorganization resulting from metabolic changes or sensory events is called emotional disturbance. The level of intelligence at any given time is a function of previously developed concepts. Perception, intimately related to conceptualization, is a summative process. Perceptual learning depends upon some consistent central action of a repeated stimulus, if the stimulus is to have a cumulative action and build up the "assembly" of cells constituting initial learning. Hebb postulates a hierarchy of "intelligence" or psychological complexity for widely differing phylogenetic levels corresponding to differences in cerebrum size, or in the proportion of afferent to internuncial neural tissues. Of great importance to education and psychlogy is his belief that organized activity of the association areas is subject to environmental control and that learning is possible only when the stimulation triggers well-organized phase sequences.

Two key points in this discussion, rejection of the telephone switchboard model, and relationship of intelligence to cerebral size have been further clarified by recent investigators. Gordon (1966) replaces the linear causation man, characterized by a telephone switchboard brain with a transactional model man characterized by a computer brain, intelligence and potential being creatable through environmental transactions. Usage stimulates brain structure and all areas participate, though in differing amounts, in input coding and response activities.

Clarification of the second point (intelligence and cerebral size), leads to the examination of three considerations: (1) the possession of large neural association areas in man compared to the lower species accounts for his intellectual supremacy at maturity; (2) initial superiority of the lower species in responding selectively to the environment is due to the A/S ratio $\frac{\text{total association cortex}}{\text{total sensory cortex}}$; if the sensory projection areas are large with respect to the association areas and so project a large number of fibers into the association cortex, control is quickly established (Hebb, 1949, pp. 124-125); and (3) the weight of the cerebral cortex appears to be in part a function of training. Krech (1962, 1963) and his colleagues demonstrated that rats reared in environmentally complex environments and subjected to intensive training differ from their littermates in the weight of the cerebral cortex; furthermore, timing and extent of experience are important factors. George Ungar (December, 1968) reported at the American Association for the Advancement of Science (Dallas, Texas) that he and his associates found learning to be transferrable from the brain of one animal to another through an extract of brain tissue. Ungar concluded, "It is highly probable that the extracts contain some highly specific information encoded in molecular structure".

The concept of motivation, not previously mentioned, takes on new meaning in this context. Gordon describes motivation as "the push of the child to structure the world". Hunt (1963) replaces drive reduction notions of motivation with ideas consonant with the child as an information processor, that is, motivation is intrinsic, and self-perpetuating, "the more a child sees and hears, the more he wants to see and hear". And Hebb (1955) states, "It appears that, up to a certain point, threat and puzzle have positive motivating value, beyond that point negative value...risk and puzzle can be attractive in themselves, especially for higher animals such as man".

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Additional studies in neurology and physiological psychology stress the inherent activity of the brain as an information-processing system. Pribham (1964) challenged traditional notions of reward and reinforcement and described brain operation in regard to T-O-T-E mechanism.

> On the basis of many new neurological facts, the suggestion has been made that the reflex arc be replaced by a feedback unit which involves (a) Text of readiness with regard to the input, (b) an Operation that seeks to match the test, (c) a re-Test to see whether match has been accomplished, before (d) Exit from control is effected. This TOTE mechanism is ubiquitous--it is essentially a modified homeostat, a mechanism which can control the very input to which it is sensitive. TOTE's are conceived to be arranged hierarchically into Plans, the antecedents of actions. And structually Plans are nothing more than Rx programs, similar to those that guide the operation of computers--well-worked-out outlines such as those used in programmed texts and teaching machines (pp. 89-90).

Thus, common neuro-physiological elements emerge to support the psychological elements previously presented. They, too, represent only a partial listing. Bloom's (1956) logically derived taxonomy of the cognitive domain, and Guilford's (1967) statistically derived factors of intellect may be examined for related evidence.

Psychologist	Common Elements
Hebb	Interfacilitating cell assemblies
Gordon	Information processing computer brain
Pribham	TOTE mechanisms

Implications for an Instructional Model

Assuming certain prerequisite abilities necessary for concept attainment, which function in a cumulative manner, the educator should be able to subdivide a specific intellectual task into its subordinate or fractional concepts or units necessary for mastery. It is further assumed that the cognitive structure desired for mastery may be identified as terminal behavior and that all ultimate conceptual goal behaviors are supported by subordinate concepts. Based on these assumptions, education may proceed in a controlled and planned manner of successive, cumulative mastery of the subordinate concepts as illustrated in Figure I (below). For hypothetical purposes, one may identify the "elemental concept" as the behavioral change he seeks to effect through direct instruction, thus contributing to attainment of broader concepts.

In order to achieve this conceptual breakdown, the concept needs first to be carefully defined, and the subordinate abilities to be mastered should command individual specification. Also, it should be remembered that each subordinate concept may in turn be a terminal concept, and would then rest upon lower order concepts before contributing to the ultimate concept achievement, as shown in Figure 2.

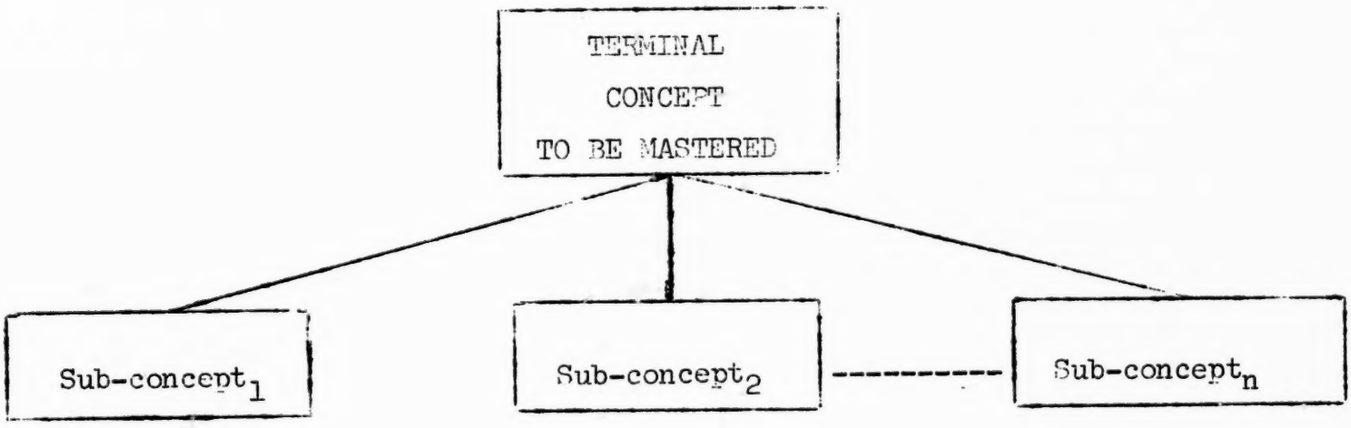


FIGURE I*

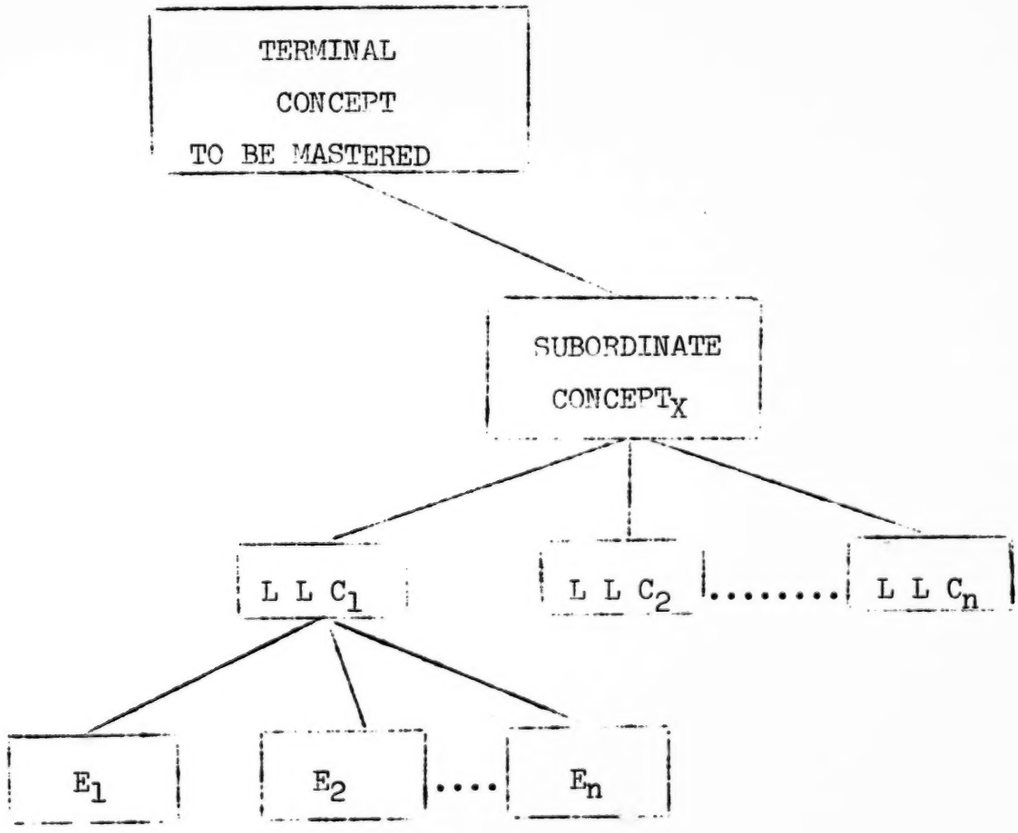


FIGURE 2*

* From Joe L. Frost and Thomas Rowland (1968).

Process and Ordinality in Human Development and Instruction

The structure of knowledge and the invariant processes of the development of intelligent behavior are intimately linked together. How are they linked and shy? The answer to this question, at least on a theoretical level, appears to be the ordinal nature of human development. The emphasis here is on the term ordinal, and is deliberately posed in opposition to normative concepts of human development.

The normative concept of human development is most often associated with the name of Arnold Gessel, and proposes that there are specific achievements which are age-related. In other words, a child at age X should be able to perform task Y. If he cannot, it is a mater of maturation or unfolding, or it is a matter of heredity. Both of these notions are largely discredited today (See J. McV. Hunt's Intelligence and Experience. 1961), nonetheless there is still widespread acceptance of the normative approach in spite of the evidence. These notions are particularly noxious in education, for they allow the school system in general and the teacher in particular to hide behind a theory as an excuse for their own ignorance, ineptitude, and inflexibility to the needs of children. The ordinal developmentalist would never say that a child should make a certain score on a certain test at a certain age, and would find the judgmental nature of normative testing repugnant no matter how well it is disguised in psychometrics. To the ordinalist there is an inherent and invariant sequence of behaviors preliminary to any developmental objective. The task of the educator is conceived to be that of determining at what point in the continuum of development the child is functioning, and then to move from there to the predetermined objective. There is no implied judgment that a child is above or below any artificial norm (Frost and Rowland, 1969).

In 1961, Piaget asserted the invariance of developmental stages saying "only the order of succession is constant". This is a notion which is intimately related to the rejection of time as a factor of primary significance in human development. The research of Flavell (1963) and Kohlberg (1966) also supports the invariance of the stages. The result of this thinking is that stages constitute an ordinal measure of human development. In the past, where the approach appeared was considered to be not only significant but the determining factor.

From the concept of the ordinality of human development, Hunt (1964) has proposed that planned experiences may well be the answer to the problems of disadvantaged or deprived children. This makes a great deal of sense, when the educator understands that development is not tied to time, and yet development is invariant and sequential. Therefore, if a child does not function appropriately it may well be the product of an environment which did not encourage or support his experiments which would have produced the central processes appropriate to the task. In such an event, the educator may be forced to intervene and provide the experiences, which should then reestablish the ordinal continuum.

Hunt (1964) provides a portion of the stimulus for this emerging effort to develop a model for instruction, the Structure-Process approach, within the context of his statement:

> The danger of attempting to prescribe materials and models ... is that the prescriptions may well fail to provide a proper match (italics mind) with what the child already has in his storage. The fact that most teachers have their expectations based on experience with culturally privileged children makes this problem of the match especially dangerous and vexing in work with the culturally deprived.

Thus Hunt seeks care in instructional prescription for the disadvantaged. Simultaneously, he alludes to the current failure of education to base instruction on antecedent conditions. His paper establishes a profound challenge for educators to reject the notions of fixed intelligence and predetermined development which underlie normative instruction and to build from existing structures in a controlled ordinal fashion.

Implementation of the Structure-Process Model

The construction of a developmental learning program based upon the premises of the Structure-Process approach requires careful attention to a number of interrelated tasks or functions. The approach simultaneously focuses upon the requirements for continuing teacher education and instructional program development, both major features being essential for success. As the interrelated tasks or functions are described, the requirements for these two major features (teacher education and program development) will be clarified.

The sequence followed in model implementation for the four early childhood centers described in this paper was necessarily tentative and emerging, characteristic of initial experimentation. This was a cooperative effort between consultants, program directors, administrators, teachers and teacher aides. Program development cannot progress far in advance of the least sophisticated member of the cooperating team. Consequently, certain elements of design and of implementation in this initial effort will undergo rather radical revision as the program proceeds. Further, the staff at each of the four centers perceived elements diversely and with varying levels of understanding. As a result, each center built in elements of program uniqueness.

Teacher Education and Program Development

The teachers and teacher aides employed in the centers (a minimum of one teacher and one aide for each twenty children) were predominantly Negro, two centers having a biracial staff. Most had received their college preparation in predominantly Negro colleges. Only seven of the twelve teachers were fully certified, though most had experience teaching in the elementary school. Most were prepared (in college) for elementary teaching. Only one had taken a course specifically designed for teachers of the disadvantaged. In the opinion of the writer, lack of formal preparation and experience in working with very young children were the most serious limitations in program development. A second limiting factor was the brevity of time for formal inservice education during the progress of the program. Teachers participated in three work sessions, preceding and during the school year, for a total of twelve days. During the initial session, most of the time was spent interacting with consultants, during the two school year sessions most of the time was spent writing curriculum material. In addition to directing these sessions, the writer (Frost) wpent approximately three to four days at each center during the school year assessing programs and working directly with the staff on program development after school hours. Periodic visits were also made by the program director, Dr. Robert Hughley, and the evaluation team headed by Dr. Robert Randall of the Southwest Educational Development Laboratory. The following pattern was used for model implementation.

Presentation of the Structure-Process Rationale

Several assumptions are made regarding the structuring of content to be learned into a hierarchical framework. (1) A teacher cannot operate analytically upon curriculum content unless she has a thorough understanding of the content in the first place. (2) Ability to inductively and/or deductively analyze content serves as a self-check by teachers regarding their level of proficiency. (3) Ability to perform in this fashion requires greater, not less flexibility of teachers. (4) The cognitive and communicative deficiencies of disadvantaged children cannot be overcome by approaches that fail to assess present cognitive levels and introduce elements of newness in a controlled fashion. (5) The teacher who can make no valid predictions regarding behavioral outcomes of a particular instructional activity is a guesswork or intuitive teacher. (6) Sequencing developmental tasks and/or cognitive content, couples with careful planning and specification of objectives in precise behavioral terms provides for effective continuous evaluation of individual children and establishes bases for their subsequent learning activity.

Setting Value Priorities

If teachers are to understand and be committed to the curriculum, they must have a part in establishing priorities. What content is to be taught? In what order? By whom? To whom? In newly designed programs, vocabulary may obscure the intent of the designers. In the centers considered here, teachers preferred the language of elmentary school curricula because that commonly utilized by early childhood specialists was unfamiliar to them. For example, the phraseology, "Mathematics and science concepts", was used to describe essentially the same global concepts described as "cognitive categories" by many early childhood educators. Upon synthesis, however, the resulting objectives were similar. Concepts of time, space, number, causality, etc., all contribute to the development of mathematics and science concepts. Simultaneously, they are fundamental cognitive learnings.

Hypothesizing and Establishing Program Objectives

The investigator or curriculum developer who wishes to approach his task in a sophisticated manner begins by establishing a list of hypothesized factors that he expects to be relevant to an area of functioning. In the present program eight global factors, not all subject to intensive structuring, were defined. They are: communications, mathematics, science, art, music, psychosocial, and the related activities, work-play and parental involvement. Figure 3 illustrates the interrelated nature and the hierarchical structure of these components. It follows that the development of pupil skill in each of these areas represents the major program goals. They are reflections of philosophy designation as specific instructional objectives. Instructional objectives emerge after careful analysis of program objectives. The successful attainment of instructional objectives ensure the eventual attainment of program objectives.

Selection and Arrangement of Significant Content: Establishing Instructional Objectives

Further hypothesizing identifies sub-components and lower order concepts which are amenable to specification as behavioral objectives. Communications, for example, was sub-categorized into four components, listening, speaking, reading, writing. These components are described as the primary linguistic skills--listening and speaking--and the secondary linguistic skills--reading and writing. Successful attainment of reading and writing is dependent upon the development of certain listening and speaking skills. Lower-order elements of these components were further identified. Listening, for example, was developed through emphasis upon specific lesson activities built upon the following elements: listening for common sounds; listening for unfamiliar sounds; listening for sounds in context; listening for sequence; listening for instructions; listening for information; listening for rhyming sounds; listening for tome and mood. Science and math components included concepts and subconcepts of time, number, space, causality, classification, conservation, serialization, color, form, etc. Content vehicles included the human body, the senses, animals, weather, plants, etc. Language, a central component of the program, was given priority in each of the global program areas. Tertiary level elements in language programming included labeling words, descriptive words, plurals, action words, polarity, position words, function words, opposites, connectives, etc., emphasizing complete sentences in lesson activiites.

The Provision of Specialized Consultative Assistance

Specialized consutation was made available in each of the major program areas. Beginning with communications, teachers were exposed to background lectures, professional materials, and group discussion to establish the bases of knowledge needed to synthesize major components into contributory elements and to prepare written behavioral objectives, procedures, and evaluation techniques. Similarly, specialists for art, music, mathematics, science, etc., were utilized.

Sequencing Order of Difficulty

Once the content of the program is identified, further hypothesizing is in order. Decisions, based on assumptions from professional study and through trial and error practice, are constantly modified to approximate a valid hierarchical order of difficulty. Continuous evaluation is a key in this respect.

Pacing of Instructional Sequences

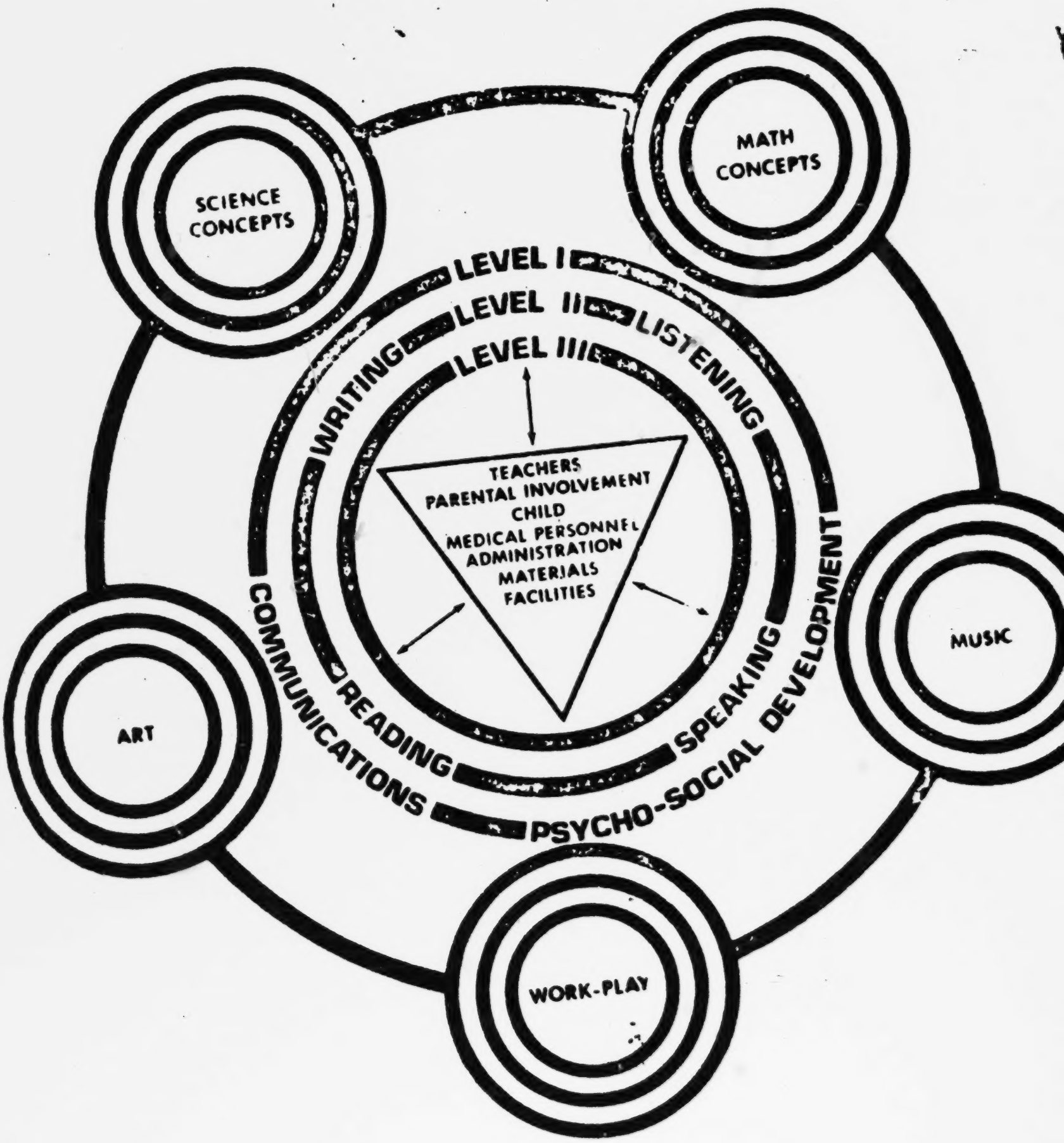
Through careful definition of behavioral objectives and resulting assessment, teachers provide for the critical match between developmental level of the child, content to be learned, and instructional technique. In essence, this is the meaning of individualization of instruction and of educative process. Operating from a diagnostic (psycho-socio-cognitive) base, teachers keep a running account of child progress and introduce elements of newness (controlled discontinuity). This requires a combination of individual, small group, and total group teaching learning activities.

Feedback and Assessment

Teachers constantly receive feedback through observation and participation in planned and spontaneous activities. They learn the child's operating level, speed of movement, and effectiveness of teaching. The child also

FIGURE 3

STRUCTURE-PROCESS FULL MODEL



receives feedback from materials and teachers that confirm or correct, allowing him to know how well he is doing and what stimuli he should focus on. In addition, he receives reinforcement for tasks performed. Two types of assessment are essential: (1) process assessment, whereby the teacher maintains continuous evaluative procedures within the context of the day-to-day activities (in this context comparative or normative scores are of little use and are often harmful); and (2) product assessment, including the use of formal and informal instruments to determine relative strengths within and between groups involved in experimentation (standard scores are quite useful in this context). The responses (not the scores) on standard instruments useful to teachers for diagnostic-teaching purposes.

Population for the Study

A total of 290 children, ages two and one-half to seven years were enrolled in the early childhood centers. This figure includes 27 first grade children enrolled in the Caddo (Shreveport) site, accounting for all of the seven- and most of the six-year-olds. Each age expressed in Table I includes a range of six months on either side, that is, age three includes all children from two and one-half years to three and one-half years old. The sites ranged geographically from a suburban metropolitan area in Houston to an isolated rural setting on an abandoned NIKE base in Bossier Parish, Louisiana. All sites were centered in economically depressed areas. All children were Negro with the exception of two Anglos.

Report of Data

Four instruments were used to collect data for assessment in the early childhood centers: the Teacher's Report, Preschool Attainment Record, Slosson Intelligence Test, and Wechsler Preschool and Primary Scale of Intelligence.

The teachers Report (TR)

This instrument was developed by the Southwest Educational Development Laboratory and was based directly on the initial objectives of the program. A checklist for each child was filled out by the teacher three times during the year, in November, January, and May. The TR attempts to assess specific progress in three program areas--communications, fine arts, and physical activities.

Analysis of variance results (Table 2) were all significant at the p .0000 level. That is, in terms of Communications, Fine Arts, Physical Activity, and the total score, highly significant differences were found between the eight groups and between boys and girls at each of the four sites. Girls were rated as more proficient by teachers, perhaps reflecting maturational superiority and/or teacher favoritism. There was a highly significant difference between trials, or the three times of reporting. Though age was not a variable, successive test scores were always higher. Anaanalysis of variance table for total score only is reported here. Review of data from all centers revealed rather erratic patterns of change over time and between centers. The TR is a reflection of initial program objectives established in the earliest stages and is not specifically keyed to the emergent curriculum.

TABLE 1

NUMBER OF CHILDREN BY AGE, SEX AND SITE
COMPILED FROM THE FEBRUARY, 1968, CLASS ROSTERS

AGE GROUP	HOUSTON Boys	Girls	Total	CADDO Boys	Girls	Total	BOSSIER Boys	Girls	Total	ORANGE Boys	Girls	Total	TOTAL Boys	Girls
3	11	3	14	4	10	14	8	5	13	2	2	4	25	20
4	7	7	14	11	27	38	6	11	17	6	9	15	30	54
5	16	19	35	12	2	14	9	11	20	15	12	27	52	44
6	8	9	17	12	7	19	2	8	10	6	5	11	28	29
7				3	5	8							3	5
Subtotal	42	38		42	51		25	35		29	28		138	152
TOTAL	80			93			60			57			290	

TABLE 2

ANALYSIS OF VARIANCE . TEACHER'S REPORT
TOTAL SCORE

SOURCE	MEAN SQUARE	D.F.	F-RATIO	P
TOTAL	2854.19	668		
BETWEEN	4081.88	222		
GROUPS	23424.09	7	6.78	.0000*
ERROR (G)	3452.14	215		
WITHIN	2243.10	446		
TRIALS	359234.27	2	856.88	.0000*
GROUP+ BY TRIALS	7262.90	14	17.32	.0000*
ERROR (T)	419.24	430		

	HOUSTON		CADDO		BOSSIER		ORANGE	
GROUP	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
MEANS	100.56	119.45	75.27	67.89	71.39	95.93	82.63	85.17
N VALID	18	23	31	39	24	34	29	25

TRIAL	Nov.	Jan.	May
MEANS	48.30	79.83	128.00

Preschool Attainment Record (PAR)

This instrument appears to be more stable than the Teacher's Report, reflecting definite and progressive growth in all categories measured. The Preschool Attainment Record is a non-standardized behavior inventory (American Guidance Service) which was administered by the child's teacher in November and May. The PAR provides a summary and profile of developmental information concerning three areas and eight categories of behavior. Physical development is appraised in terms of ambulation and manipulation; social development is appraised in terms of rapport, communication, and responsibility; intellectual development is appraised in terms of information, ideation, and creativity. In addition, the PAR provides background information and relevant family data concerning each child. PAR's were filled out for all children by the teachers in November 1967 and May 1968. These data include results for a twenty per cent sample (27) of first graders at the Shreveport site. Table 3 reflects loss of information for the Orange site.

Average performance of children reflects the cumulative deficiency phenomenon characteristic of disadvantaged children. At pretest three-year-olds were above age level in all eight categories; four-year-olds in six categories; five-year-olds in five; six-year-olds in two; and seven-year-olds in two. At posttest, the three-, four-, and five-year-old groups were performing above age level in all eight PAR Categories. The six-year-olds were still performing below age level in Communication and creativity. The seven-year-olds had reached the ceiling of the test in all categories. Thus the cumulative

deficiency phenomenon appeared to be erased for children under the age of six. Analysis of variance resulted in highly significant differences for all PAR categories and for all age groups, in all comparisons posttest scores equaled or exceeded pretest scores (Table 3).

Slosson Intelligence Test (SIT)

This is a short, standardized, individually administered, verbal intelligence test (Slosson Educational Publications). The SIT was administered to every child by a team of trained testers in the fall, 1967, and spring, 1968.

In the fall, pretest IQ scores decreased as a function of increasing age, confirming the cumulative deficit notion (Table 4). In the spring, after six months in the program, there was a marked increase in IQ's for the four-year-old group. The IQ's for the three-, five-, and six-year-old groups were found to be lower than pretest scores. Plotting IQ as a function of increase in chronological age resulted in a different picture, only the six-year-olds lost ground while three- and five-year-olds held their own and four-year-olds made considerable progress. Therefore, the early childhood program appeared to prevent accumulation of further deficit for three- and five-year-old groups, and reversed this trend for four-year-olds. Since it is believed that the pretest scores may have overestimated IQ to some degree due to alterations in administration and scoring, thus minimizing pretest--posttest differences, this is a conservative conclusion.

TABLE 3

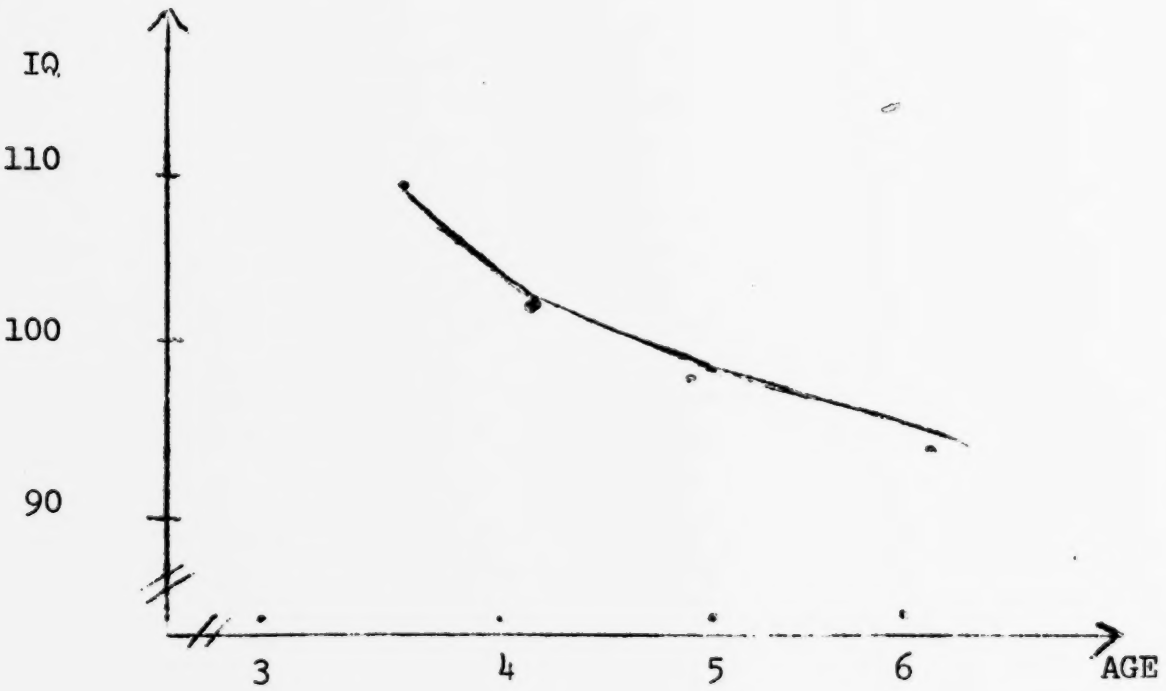
PAR RAW SCORES - PRE- AND POSTTEST
COMPARISON BY CATEGORY AND SITE

PAR CATEGORY	MEAN SCORE BY SITE											
	CADDO		BOSSIER		HOUSTON		F-RATIO	P	ORANGE*			
	PRE	POST	PRE	POST	PRE	POST			PRE	POST		
PHYSICAL												
Ambulation	11.88	12.38	9,89	12.87	13.11	13.30	18.23	.0001	11.96	12.69		
Manipulation	10.37	10.95	8.70	12.10	12.08	12.36	10.85	.0015	(F = 10.82) (P = .0015)			
SOCIAL												
Rapport	10.78	11.35	8.34	11.90	11.94	12.44	16.46	.0002				
Communication	8.52	9.51	8.26	11.35	8.36	9.63	20.60	.0001	9.00	10.42		
Responsibility	11.49	11.17	8.92	12.34	11.15	11.89	7.89	.0054	(F = 19.25) (P = .0001)			
INTELLECTUAL												
Information	10.60	11.57	8.89	12.51	9.89	10.61	20.80	.0001				
Ideation	9.72	10.18	7.74	11.83	9.53	10.47	24.76	.0000				
Creativity	8.79	9.76	7.90	11.44	7.58	9.67	23.66	.0000				
Posttest N	90		61		69				58		TOTAL	
Pre-Posttest N	89		58		43				55		278	
											245	

TABLE 4

MEAN PRETEST SIT SCORES BY AGE GROUPS

	3 year olds (31-42 mo.)	4 year olds (43-54 mo.)	5 year olds (55-60 mo.)	6 year olds (67-78 mo.)
M	110.0000	105.6119	101.1818	97.2439
SD	12.6034	15.9750	14.4600	12.9233
N	26	67	66	41



According to the analysis of variance (Table 5), there were no significant differences between pre- and posttest IQ scores, and no significant sex differences. There was a highly significant difference ($p > .0000$) between age groups.

TABLE 5
ANALYSIS OF VARIANCE

SLOSSON INTELLIGENCE TEST

SOURCE	M.S.	D.F.	F-RATIO	P
Total	218.71	373		
Between	668.97	15		
Pretest, Posttest	14.25	1	.07	.7859
Boys-Girls	43.54	1	.22	.6462
Age	2978.81	3	14.90	.0000*
Trials by Sex	28.27	1	.14	.7087
Trials by Age	190.16	3	.95	.5826
Sex by Age	118.32	3	.59	.6248
Trials by Sex by Age	28.87	3	.14	.9325
Within	199.85	358		

Wechsler Preschool and Primary Scale of Intelligence (WPPSI)

This is a relatively new extension of the Wechsler Intelligence Scale for children. It is a standardized and individually administered intelligence test (The Psychological Corporation). It provides a verbal IQ, performance IQ, and full scale IQ. It was administered by a team of trained testers, to twelve four and five-year-old children from the four early childhood centers. This check on validity for the shorter Slosson Intelligence Test, was primarily due to the assumed inflated IQ scores derived from the Slosson. Table 6 shows the comparative results of testing with the SIT and WPPSI. The WPPSI IQ's are consistently lower than the SIT. In every case, children who tested superior and very superior on the SIT tested average on the WPPSI. Children who tested average on the SIT tested borderline on the WPPSI. The WPPSI scores are much more in keeping with the expected from a disadvantaged population. A trial by subject analysis of variance of the differences between the scores on these two test yielded a probability of .001 that the two measures were equal. However, the correlation between scores on the two tests is .84, indicating that the relative standing of children on the two tests is highly consistent. The absolute value of these IQ scores is dramatically different. Compared to the WPPSI, the SIT appears to consistently overestimate IQ. It is quite likely, of course, that the two tests are not measuring the same thing though both purpose to measure "intelligence".

TABLE 6

MEAN, RANGE AND STANDARD DEVIATION OF SIT AND WPPSI SCORES

	Slosson IQ	WPPSI Full Scale IQ
Mean	112.25	86.67
Range	86-146	69-101
S.D.	19.18	10.81
N.	12	12

Health Records

Although health is not specifically involved in the evaluation of the structure process model, the health information from early childhood centers has relevance to planning and conducting programs. Most children in all centers received extensive medical examinations, including physicals, hearing, vision, and dental. The Bossier center referred 11 children for dental treatment, four for impetigo and one for tonsillectomy. The Shreveport (Caddo) center urinalysis examinations revealed 11 cases of serious infection, five cases of enlarged tonsils, three under weight cases, three cases of infected lesions, one case of impetigo, one umbilical hernia, and one advanced case of dental decay. Twenty-eight home visits were made for health reasons. Incomplete records from Houston revealed two cases of bronchitis, six cases of "intoeing", two cases of advanced impetigo, six cases of skin problems, and three external ear problems. Twenty-one children were referred to a Clinic for treatment. In the orange center, six children were fitted with glasses. The relatively careful examinations in this center revealed 23 cases of general skin problems including ulcers, infected cuts, dermitis, 13 cases of impetigo, eight cases of infected tonsils, 12 cases with ear problems, six cases with umbilical hernias, seven cases with bronchial difficulties, two with heart murmurs, two with pronounced dental decay, one case of worms, one case of anemia, one fever of unknown origin, and one child with a cleft palate. Whenever possible and necessary, the child was treated or referred for treatment. The services or an especially capable and conscientious nurse at the Orange center probably accounted for the relatively large number of problems diagnosed and treated.

SUMMARY

The Structure-Process approach to cognition and literacy assumes that certain prerequisite abilities are necessary for concept attainment; that intelligence develops in a cumulative manner. Consequently, educators should be able to deductively analyze a specific intellectual task into its subordinate structural units for instructional purposes. The fundamental process of education is the provision of controlled discontinuity operating from a base of continuity. Time, Per se, is viewed as an irrelevant variable in the instructional process, serving only as a backdrop against which events transpire. Ordinal bases, versus traditional normative bases, are critical considerations in programming for young children.

Under the auspices of the Southwest Educational Development Laboratory, the Structure-Process approach was used for curriculum development in two

Texas and two Louisiana (rural and urban) early childhood centers enrolling 290 three, four, five and six-year-old disadvantaged Negro Children during the 1967-1968 school year.

The Teachers Report

The Teachers Report, an informal checklist of activities based on specific objectives, administered during November, January, and May, revealed significant gains in communications, fine arts, and physical activities. Significantly higher gains were found for girls compared to boys. No significant differences were found on other instruments, suggesting a tendency for teachers to favor girls.

Preschool Attainment Record

Pre and post administration produced significant gains on measures of creativity and physical, social, and intellectual development.

The Slosson Intelligence Test

The Slosson Intelligence Test pretest and posttest scores were not significantly different for the total population (disadvantaged children usually follow a cumulative deficiency pattern). Three and five-year-olds retained initial levels, four-year-olds made significant gains, and six-year-olds lost ground, implying maximum effect of the program for younger children. These results appear to be conservative. Cross-test comparisons and variations in administration of instruments indicate that pretest scores may have been inflated, thus reducing pretest-posttest differences.

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